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CHINA'S NEWLY DESIGNED AND BUILT AIRCRAFT ENGINE TEST STAND.(U)
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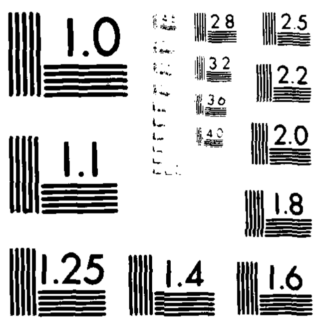

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FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

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TEST STAND

FOREIGN TECHNOLOGY DIVISION

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CHINA'S NEWLY DESIGNED AND BUILT AIRCRAFT ENGINE TEST STAND
by an International Aviation correspondent

After more than two years of work, China's newly designed and built aircraft engine test stand underwent quality evaluation and was officially put into use in July 1979. The successful construction of the new test stand has provided an essential prerequisite for Chinese designed and produced large jet engines.

This test stand was designed by the Third Machine Industry Department of the Fourth Planning and Design Institute, referring to a "Spey" engine test program provided by the Rolls Royce Company of Great Britain, and was built by the Sian Red-banner Machine Factory.

In the design process, the Fourth Planning and Design Institute summed up the experiences in the fields of domestic test stand design, constuction, operation and scientific research, assimilated the strong points of the various foreign projects, and carried out the necessary experimental research in new schemes, causing the ultimate design of the test stand (Fig. 1) to be distinguished by a structure which is new and original, an arrangement which is compact and test equipment which is relatively advanced.

The performance specifications of this test stand are comparatively high. For instance, the measurement accuracy of thrust and fuel flow are $\pm 0.25\%$ and $\pm 0.2\%$, respectively. The test stand's principal

performance figures are as follows:

Maximum measured thrust	up to 15,000 kg
Thrust measurement accuracy	±0.25%
Test stand thrust correction	When thrust exceeds 3856 kg, the amount of correction is 140 kg; when thrust is less than this value, it is corrected according to the correction curve and the correction factor is 1.5%
Engine fuel flow rate measurement accuracy	±0.2%
Test bay pressure drop	14 mmH_2O
Exhaust outlet ratio	1:1.77 (i.e., the cooling gas flow rate is 177% that of the exhaust gas
Engine intake air temperature measurement accuracy	±0.1°C
Air flowmeter correction factor "K"	1.001

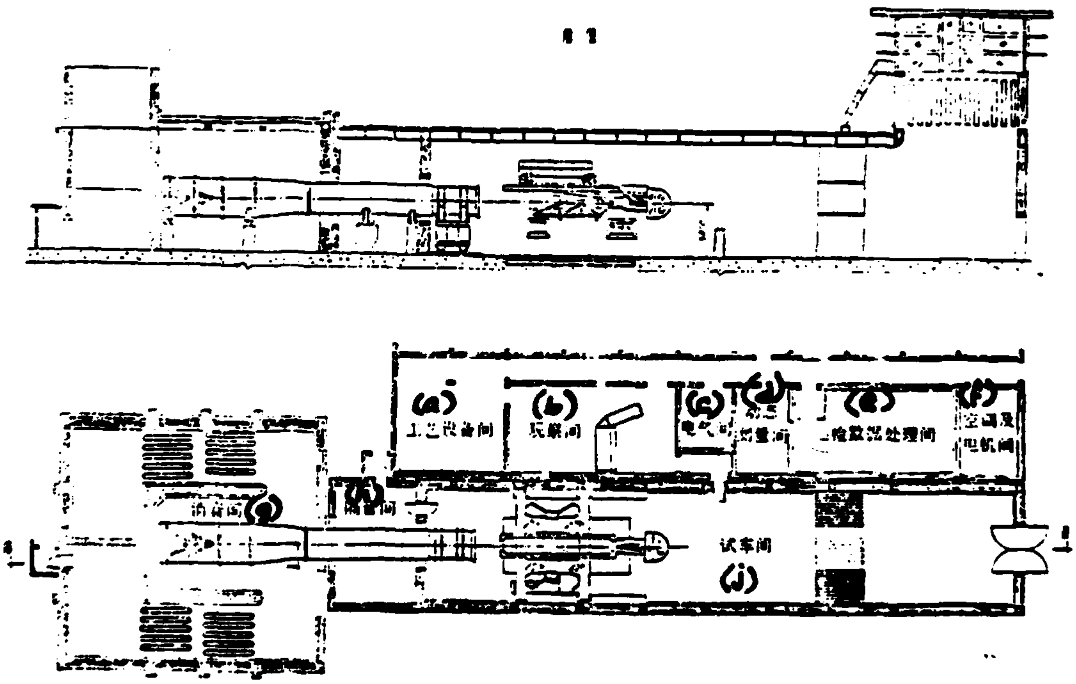

Fig. 1. Technical drawings of China's newly designed aircraft engine test stand

KEY: (a) Technological equipment room; (b) Observation room; (c) Electrical room; (d) Dynamic measurement room; (e) Inspection and data processing room; (f) Air conditioning and electrical machinery room; (g) Sound deadening room; (h) Sound-proof room; (j) Test bay

Also, in the areas of technological and aerodynamic layout, noise control, adaptability, mounting utilization, quite satisfactory results have been obtained.

Accordingly, in July 1979, the new test stand was officially determined to be up to standards and can be used for conducting tests on existing domestic large engines including the "Spey" engine and in particular it has the capability for conducting 150-hour endurance tests.

The construction of this modernization project has not only developed and tempered a number of qualified technicians, but also the construction work was completed one year earlier than having the complete set of equipment imported from abroad, and moreover a large amount of the nation's investment was saved. The investment in the test stand platform and system equipment portion alone accounted for only 3.6% of the import cost, meaning the nation saved a large amount in foreign exchange. They have persistently shown this kind of self-reliance and have been adept at drawing vitality from the experience of foreign countries and have received the praise of the comrades of the central leadership.

Some new technology has been employed in the design of the test stand. The following items are some rather outstanding examples of this technology:

SUSPENSION TYPE TEST STAND MOUNTING (Fig. 2)

In comparison with certain types of foreign test stand mounts as well as those previously designed by China, this type of test stand mounting has the advantages of a simple structure, good rigidity, highly accurate thrust measurement, wide viewing field and ease of installation and operation. In structure, its stationary mount is fastened to "rod-shaped bases" on the two side walls and the movable mount is suspended from the fixed mount by means of four spring leaves. The engine thrust is read out via high accuracy sensors and digital and analog instruments. The measurement accuracy of the digital

instruments is $\pm 0.25\%$.

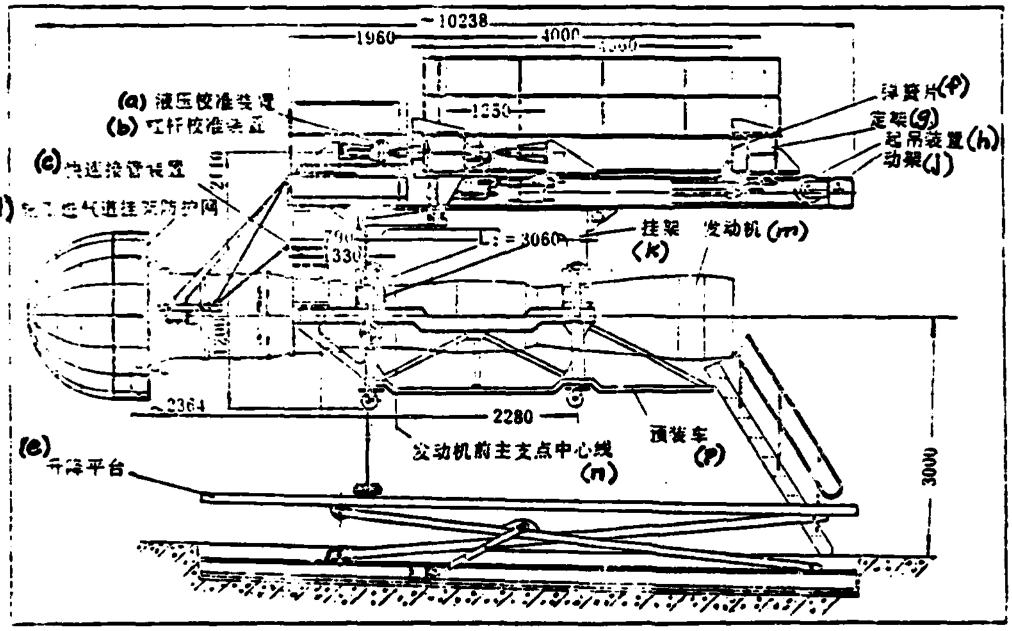

Fig. 2. Suspension type test stand mounting

KEY: (a) Hydraulic calibration equipment; (b) lever calibration equipment; (c) High-speed control equipment; (d) Protective mesh covering operating intake duct; (e) Lifting platform; (f) Spring leaf; (g) Stationary mount; (h) Hoisting device; (j) Movable mount; (k) hanger mount; (m) Engine; (n) Engine main forward support point center line; (p) Engine dolly

In order to improve thrust measurement accuracy, other than by improving sensor and secondary instrument accuracy and mounting rigidity (the amount of mount movement has been lowered from 1.34 mm to 0.9 mm) two thrust calibration systems were also employed. One of these is a lever calibration system; after painstaking work and testing its accuracy has reached 0.089%, surpassing the original design requirement of 0.1%. The other is a hydraulic calibration system which uses a high accuracy standard hydraulic pressure thrust measurement system to calibrate the operating sensors and secondary instruments. Employment of these methods has already alleviated the labor intensity of the workers and has also caused thrust calibration operations to move a gratifying step in the direction of automation.

In addition to this, also employed in the design are a suspension

dolly, high speed control equipment, and a "scissor" type 8 X 4 m large hydraulic drive operating platform for lifting and installation. This has not only improved working conditions and improved mounting utilization but can ensure that there is a good flow field during test runs. At the same time, since the frontal area of the test stand framework is small the test bay pressure drop is also fairly small.

SOUND DEADENING EQUIPMENT

In order to ensure the aerodynamic and sound deadening properties of the U-shaped test bay, horizontal and vertical sound deadening sections have been designed into the intake area. Of these, the movable type horizontal sound deadeners are the first domestic made ones to be designed and put into operation. They can ensure that the intake air is relatively clean and that the interior flow field is relatively uniform, they change the radiation directivity of the engine noise and reduce the noise level of the intake duct, particularly in the ready room. The measured results indicate that the pressure drop in the airflow after passing through the intake duct is approximately 14 mmH_2O, the maximum sound pressure level at the vertical intake opening is 86 dB (A), and the maximum sound pressure level inside the ready room is only 62 dB (A); a fairly good level has been acheived.

In the design for sound deadening of the exhaust, reference was made to the experiences of foreign countries and a new scheme was worked out for exhaust sound deadening consisting of two horizontal side baffle-plates and damping type sound deadeners. This scheme went through model testing and a large amount of data was obtained. The test indicated that the aerodynamic and sound deadening properties of this system are both relatively good. In addition, during designing they also employed an exhaust outlet pipe with a telescopic movable section and a perforated diffusor as well as new Sian-78 type heat-proof sound absorbing bricks which have been successfully developed. The measured results prove that this type of exhaust sound deadening equipment already satisfies one or two of the existing

requirements for control of the coefficient of radiation during engine testing and also allows exhaust duct noise deadening to reach a fairly good level, the maximum measured sound pressure level at the outlet being 86 dB (A).

TEST STAND MEASUREMENT CONTROL AND FUEL SYSTEMS

The test stand measurement control system employs a number of domestic transducers and secondary instruments of relatively high accuracy, such as platinum resistor T_1 temperature gauges, thrust measurement instruments and digital tachometers. In addition, it also employs a deaerator in the engine fuel system which improves the accuracy of fuel measurement and a DDZ-II electrodynamic combination unit has been employed in the air starting system which ensures the stability of the starter intake pressure and satisfies the requirement for three successive starts within ten minutes.

THE STRUCTURAL DESIGN OF THE FACILITY

After conducting a comprehensive analysis of domestically available test stands, they passed over test bay three dimensional structures employing construction methods of entirely reinforced concrete, and changed to a reinforced concrete frame method. Practice has proven that this kind of method can satisfy stress requirements and can also save investment and shorten the construction period. In the structural scheme for building the surrounding shield of the exhaust duct noise deadening equipment, a double layer bearing structure was employed consisting of a reinforced concrete wall and an inner brick walls as well as Sian-78 type granular sound absorbing brick lining the masonry. This has obtained fairly good results both for preventing cracking of the outer walls and for reducing noise.

In short, comparatively new technology has been employed in the design of this test stand and fairly good results have been obtained, but during the shakedown tests a number of problems appeared. For instance, the water jet system has still not been perfected. As we have said, these problems will soon be resolved.

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